SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S01NCSTA01**	Statistical Inference-I	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Evaluate the properties of sufficient statistics — including minimal sufficiency, completeness, and ancillarity — for various probability distributions and use it in construction of estimators and test statistics.

CLO2: Construct Uniformly Minimum Variance Unbiased Estimators (UMVUEs) and evaluate its properties including lower bounds and large sample properties.

CLO3: Derive and compare point estimators using the method of maximum likelihood (MLE), method of moments, minimum chi-square, UMVUE and Bayes estimation under squared error loss, while critically analysing their large-sample properties and optimality criteria including equivariance.

CLO4: Design most powerful and uniformly most powerful (UMP) tests for one-sided and locally most powerful (LMP) two-sided alternatives by applying the generalized Neyman–Pearson lemma, its randomised generalisation, the monotone likelihood ratio property, and UMP unbiased tests for various distribution parameters.

CLO5: Assess and apply large-sample inferential procedures — including the Likelihood Ratio Test, and the Sequential Probability Ratio Test (SPRT) for practical hypothesis testing scenarios.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Sufficiency, Completeness and Ancillarity • Sufficiency: Principle; factorization theorem; minimal sufficiency; construction of minimal sufficient statistics for exponential family and other probability distributions. • Completeness, bounded completeness and complete sufficient statistic; ancillary statistics; Basu's theorem and its applications.	CL, PBL	1 2 3 4
II	Best Point Estimation and Information Bounds • Unbiased estimators; Uniformly Minimum Variance Unbiased Estimators (UMVUE); Rao-Blackwell theorem and Lehmann-Scheffé theorem and their applications. Fisher information and the information matrix; Cramér-Rao inequality; Chapman-Robbins bounds; Bhattacharyya bounds and their applications. • Method of maximum likelihood (MLE); large-sample properties of MLE; method of scoring and its application to estimation in multinomial distribution; MLE in non-regular families. • Other methods of estimation: method of moments, minimum chi-square, and modified minimum chi-square.	CL, PBL, ICT EL	2 3

III	Most Powerful and UMP Tests • Randomised tests; randomised version of the Neyman-Pearson lemma and its generalisation. Uniformly most powerful (UMP) tests for one-sided alternatives for one-parameter exponential family; the monotone likelihood ratio (MLR) property. • Unbiased tests and their applications to one-parameter exponential families; UMP unbiased tests for parameters of the normal distribution. • Confidence bounds: Theory of confidence Intervals and Test of Hypothesis. Estimation of Shortest Confidence Intervals; Concept of Confidence region and bounds.	CL, PBL	3 4
IV	Likelihood Ratio Tests and Sequential Testing • Likelihood Ratio Test (LRT): Construction of LRT (Independent, paired sample t-test, ANOVA F-test) and its large-sample properties; consistency of tests; asymptotic distribution of LRT statistic. • Sequential Probability Ratio Test (SPRT): Test procedure and properties of SPRT with its fundamental identity.	CL, PBL, ICT EL	3 5

- **(*) Learning Pedagogies/Methods**
- Classroom Lecture (CL)
- Case-Based Learning (CBL)
- Problem-Based Learning (PBL)
- ICT-Enabled Learning through Digital Resources/ Virtual Labs/Webinars (ICT EL)
- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment

i. Assignment
ii. Seminar/Presentation

b. Internal Summative Assessment

i. Mid-term tests
ii. End of Term Examination
iii. Laboratory performance
iv. Viva-voce

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1-2-3-4	30	1	1	12	14
II	CLO2, CLO3	32	1	1	10	12
III	CLO3, CLO4	28	1	1	10	12
IV	CLO3, CLO5	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

Master of Science Statistics Semester-I

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25%
		SA: Mid Term Test	25%
2	End-Semester Examination	Written Exam	50%

(C) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	–	–	1	1	2	–	–	1	–	–	–	–	2	3	–
CLO2	–	–	3	1	2	–	–	1	–	–	–	–	2	3	–
CLO3	2	–	3	1	2	–	–	1	–	–	–	–	2	3	–
CLO4	3	–	3	3	2	–	–	1	–	–	–	–	2	3	1
CLO5	3	–	3	3	2	–	–	1	2	–	–	–	2	3	1

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Theory of Point Estimation	E. L. Lehmann & G. Casella	2nd, 1998	Springer
2	Testing Statistical Hypotheses	E. L. Lehmann & J. P. Romano	3rd, 2005	Springer
3	Statistical Inference	G. Casella & R. L. Berger	2nd, 2002	Duxbury Press
4	Introduction to Mathematical Statistics	R. V. Hogg, J. McKean & A. T. Craig	8th, 2019	Pearson
5	An Introduction to Probability and Mathematical Statistics	V. K. Rohatgi & A. K. Md. E. Saleh	3rd, 2015	Wiley

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL – Statistical Inference (IIT)	https://nptel.ac.in/courses/111/104/111104091/
2	MIT OpenCourseWare – Statistical Estimation	https://ocw.mit.edu/courses/mathematics/

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NESTA01**	Matrix and Linear Models Theory	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Demonstrate understanding of vector spaces, linear transformations, matrix algebra and special matrices and apply these concepts to solve problems in linear systems and matrix representations.

CLO2: Analyze eigenvalues, eigenvectors, matrix factorizations, and generalized inverses and evaluate their role in solving systems of equations and statistical applications.

CLO3: Derive Least Squares Estimators (LSEs) within the Gauss-Markov framework by applying normal equations, error-estimation spaces, and distributional results for sums of squares in model and error.

CLO4: Design tests of hypotheses and construct confidence intervals for one and several linear parametric functions — integrating Analysis of Variance, and multiple-comparison procedures (Tukey and Scheffé) — by applying general linear model theory.

CLO5: Synthesise results on generalised inverses (g-inverses), simultaneous estimation, and one-way random-effects models to solve complex linear model problems.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Vector Spaces and Matrix Algebra • Vector Spaces, Subspaces, linear independence, Spanning Sets, Basis, Dimension, Kernel and Range, Matrix Representation of Linear Transformations, • Algebra of Matrices, Diagonal and Triangular Forms, Trace and Rank of a Matrix and their Properties, Determinant and Inverse (including Partitioned Matrices), Orthogonal and Idempotent Matrices and their Properties. Eigenvalues and Eigenvectors.	CL PBL ICT EL	1 2 5
II	Quadratic Forms and Matrix Inverse • Matrix Factorizations: Spectral Decomposition, Singular Value Decomposition (SVD), Cayley-Hamilton Theorem, Quadratic Forms and Positive/Negative Definiteness (with proofs), • Generalized Inverses (g-inverses) and their properties (with proofs), Methods of Constructing g-inverses • General Solution to a System of Linear Equations, Matrix Derivatives and Jacobians, Applications of Matrix Algebra in Statistics.	CL PBL ICT EL	2 5
III	Linear Models and Gauss-Markov Theory • Linear Statistical Models: Definition and classification of linear models; model matrices and identifiability; Normal	CL PBL	1 3 4

	Equations and Least Square Estimators, Error and estimation spaces, variances and covariance of least square estimators, estimation of error variance. Distributions of model and error sum of squares • Gauss-Markov Theorem: BLUE property of OLS estimators and its proof under the Gauss-Markov assumptions. Ordinary and generalised least squares estimators and their geometric interpretation.		
IV	Estimation and Testing of Model • Estimable Functions: Conditions for estimability and confidence regions for estimable linear functions. simultaneous estimators of linear parametric functions. • Test of Linear Models: Tests of hypotheses for one and more than one linear parametric functions, confidence intervals and regions, F-tests in general linear models and ANOVA as a special case. • Multiple comparison tests due to Tukey and Scheffe, simultaneous estimation of linear parametric functions.	CL CBL	3 4 5

- **Learning Pedagogies/Methods**
  (a) Classroom Lecture (CL)
  (b) Case-Based Learning (CBL)
  (c) Micro-Projects (MP)
  (d) Problem-Based Learning (PBL)
  (e) ICT-Enabled Learning through Digital Resources/ Virtual Labs/Webinars (ICT EL)
- **Assessment Methodologies**

(D) Internal Assessment

a. Internal Formative assessment

i. MCQ and Objective question Quiz: Students select or give the correct answer from the list of options four /none for a given question.
ii. Assignment: A practical task or setup questions given to measure a student's knowledge, skill and ability in subject or field.
iii. Seminar: A student-led academic activity designed to evaluate student's ability to research, understand, and present a specific topic.
iv. Group Discussion: An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment

v. Mid-term tests
A test conducted roughly halfway through an academic term or semester.
vi. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.
vii. Viva-voce
An oral examination conducted to evaluate a student's in-depth knowledge, understanding, and critical thinking regarding a subject or project.

(E) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 2, 5	30	4	5	3	12
II	2,5	30	4	5	4	13
III	1,3,4	30	4	5	4	13
IV	3,4, 5	30	3	5	4	12
		120	**15**	**20**	**15**	**50**

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage(%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25%
		SA: Mid Term Test	25%
2	End-Semester Examination	Written Exam	50%

(F) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	-	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	**1**
CLO2	-	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
CLO3	**1**	**3**	-	**2**	**1**	**3**	-	-	-	-	-	-	-	**3**	-
CLO4	**2**	**3**	**1**	**3**	**2**	-	-	-	-	-	-	-	**2**	**3**	-
CLO5	-	**3**	**1**	-	**3**	-	-	**3**	-	-	-	-	**2**	**3**	-

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Linear Statistical Inference and its Applications	Rao, C. R.	Second/2001	Wiley Eastern Ltd.
2	A Course in Linear Models, Statistics: Textbook and Monographs	Kshirsagar, A.	First/1983	Marcel Dekker, Inc.
3	Applied Matrix Algebra in the Statistical Sciences	Basilevsky, A.	1983	NewYork North-Holland
4	Introduction to matrices with Applications in Statistics	Graybill, F. A.	1969	John Wiley
5	Matrix Algebra useful for Statistics	Searl, S. R.	First/1982	John Wiley

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S01NESTA02**	Matrix and Operations Research	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Demonstrate understanding of vector spaces, linear transformations, matrix algebra and special matrices and apply these concepts to solve problems in linear systems and matrix representations.

CLO2: Analyze eigenvalues, eigenvectors, matrix factorizations, and generalized inverses and evaluate their role in solving systems of equations and statistical applications.

CLO3: Apply network analysis techniques such as CPM and PERT, and analyze deterministic and probabilistic inventory models to support decision-making in operations and management problems.

CLO4: Demonstrate knowledge of queuing systems and analyze performance measures of models like M/M/1 and M/M/C, and evaluate their applications in real-life service systems.

CLO5: Apply matrix algebra, network models, and queueing theory concepts using computational tools to analyze real-world data and communicate results effectively.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Vector Spaces and Matrix Algebra • Vector Spaces, Subspaces, linear independence, Spanning Sets, Basis, Dimension, Kernel and Range, Matrix Representation of Linear Transformations. • Algebra of Matrices, Diagonal and Triangular Forms, Trace and Rank of a Matrix and their Properties, Determinant and Inverse (including Partitioned Matrices), Orthogonal and Idempotent Matrices and their Properties.	CL PBL ICT EL	1 5
II	Eigenvalues and Applications of Matrix Algebra • Eigenvalues and Eigenvectors, Matrix Factorizations: Spectral Decomposition, Singular Value Decomposition (SVD), Cayley-Hamilton Theorem, Quadratic Forms and Positive/Negative Definiteness (with proofs) • Generalized Inverses (g-inverses) and their properties (with proofs), Methods of Constructing g-inverses, General Solution to a System of Linear Equations, Matrix Derivatives and Jacobians, Applications of Matrix Algebra in Statistics.	CL PBL ICT EL MP	2 5
III	**Network Analysis and Inventory Control Models** • Network Analysis: Definition and formulation, critical path method, Project Evaluation and Review Technique (PERT) • Inventory control problems: Reasons for carrying inventory, Deterministic inventory control models with and without	PBL CL CBL MP	3 5

	shortages, Problem of EOQ with quantity discounts, Inventory problems with uncertain demand: single period problem without set-up cost and single period model with set-up cost (s, S)) policy.		
IV	Queueing Models • Queueing Theory: Introduction, structure of Queuing system, performance measures of a queuing system, Real-Life examples • Queuing Models: Steady state solution of M/M/C/∞/FIFO and M/M/C/N/FIFO with associated distributions of queue length and waiting time. (C=1 as particular case).	CL CBL ICTEL PBL	4 5

Learning Pedagogies/Methods

(f) Classroom Lecture (CL)
(g) Case-Based Learning (CBL)
(h) Micro-Projects (MP)
(i) Problem-Based Learning (PBL)
(j) ICT-Enabled Learning through Digital Resources/ Virtual Labs/Webinars (ICT EL)

- **Assessment Methodologies**

(G) Internal Assessment

a. Internal Formative assessment (25 Marks)

v. **MCQ and Objective question Quiz:** Students select or give the correct answer from the list of options four /none for a given questions.
vi. **Assignment:** A practical task or setup questions given to measure a student's knowledge, skill and ability in subject or field.
vii. **Seminar:** A student-led academic activity designed to evaluate student's ability to research, understand, and present a specific topic.
viii. **Group Discussion:** An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment (25 Marks)

i. Mid-term tests
A test conducted roughly halfway through an academic term or semester.

ii. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.

iii. Viva-voce
An oral examination conducted to evaluate a student's in-depth knowledge, understanding, and critical thinking regarding a subject or project.

(H) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 5	30	4	5	3	12
II	2, 5	30	4	5	4	13
III	3, 5	30	4	5	4	13
IV	4, 5	30	3	5	4	12
		120	**15**	**20**	**15**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25
		SA: Mid Term Test	25
2	End-Semester Examination	Written Exam	50

(I) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	**3**	-	**3**	-	**3**	-	-	**2**	-	-	-	-	**1**	-	-
CLO2	**2**	-	**3**	-	**3**	-	-	**3**	-	-	-	-	**2**	-	-
CLO3	**3**	**2**	**2**	-	**3**	-	-	**3**	-	-	-	**1**	-	-	**1**
CLO4	**3**	-	**2**	-	**3**	-	-	**2**	-	-	-	-	-	-	-
CLO5	**3**	-	**2**	-	**3**	**2**	-	**2**	**2**	**3**	**1**	**2**	**2**	**1**	**1**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Applied Matrix Algebra in the Statistical Sciences	Basilevsky, A.	1983	NewYork North-Holland
2	Introduction to matrices with Applications in Statistics	Graybill, F. A.	1969	John Wiley
3	Matrix Algebra useful for Statistics	Searl, S. R.	First/1982	John Wiley

4	Introduction to Operations Research	Hillier, Frederick S., and Gerald J. Lieberman	11th Edition/ 2018	McGraw Hill Education India
5	Operations Research: Problems and Solutions	Sharma, J. K.	2002	Macmillan India Ltd.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Operations Research By Prof. Rajendra Singh | IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc25_ag15/preview

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Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S01NESTA03**	Probability and Distribution Theory	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Demonstrate knowledge of axiomatic probability, conditional probability, Bayes' theorem, and advanced concepts like convergence in probability and distribution.

CLO2: Analyze discrete and continuous random variables, joint, marginal, and conditional distributions, and calculate moments, Cumulative Distribution Functions (CDF).and probability models using Characteristic Functions

CLO3: Apply the identified probability distributions (e.g., Cauchy, Beta, Gamma, Weibull, Pareto, Log-Normal) for data modelling.

CLO4: Evaluate convergence criteria and apply the Weak/Strong Laws of Large Numbers (LLN) and Central Limit Theorems (CLT) to analyse large sample behaviours.

CLO5: Derive properties of sampling distributions (t, F, Chi-square, min, max), multivariate distribution and understand the mathematical foundations of statistical inference (estimation theory) towards modelling complex data scenarios

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Measurement of Events • Probability and random Variables: Classes of Events and Data, Limit of sequence of events, Probability, Axiomatic approach, Random Variables and vectors, Decomposition of Distribution Function • Expectation and Moment's Inequalities: Expectation including Conditional expectation, Characteristic function, Holder's and Cauchy-Schwartz, Basic, Markov and Chebyshev, Jensen's and Liaponouv's inequalities, Multiplication Theorem of expectation	CL PBL ICT EL	1 2 4
II	Measurement of Sequence of Events • Modes of Convergences: Four modes of Convergences, Inversion theorem of characteristic function • Convergence Theorems: Weak and Strong Laws of large numbers, Central Limit Theorems for iid and independent sequence of random variables	CL PBL ICT EL	1 4
III	Statistical Modelling of Events and Data • Probability Distributions: Transformation of random variables, Generating Functions, Discrete & Continuous distributions (including advanced types), distribution function of sums and product of random variables • Sampling distributions: central and non-central t-, chi-square, F- distributions and their MGF and CGF	CL ICT EL	3 4

Master of Science Statistics Semester-I

IV	Statistical Modelling of Joint Events • Joint Probability Distributions: Joint distributions, marginal distributions, conditional distributions, mixture distributions for bivariate normal distribution. • Multivariate Distributions: distribution of order statistics, multinomial and multivariate distribution	CL CBL MP	3 4 5

- **Learning Pedagogies/Methods**
  (k) Classroom Lecture (CL)
  (l) Case-Based Learning (CBL)
  (m) Micro-Projects (MP)
  (n) Problem-Based Learning (PBL)
  (o) ICT-Enabled Learning through Digital Resources/ Virtual Labs/Webinars (ICT EL)
- **Assessment Methodologies**

(J) Internal Assessment

a. Internal Formative assessment

ix. **MCQ and Objective question Quiz:** Students select or give the correct answer from the list of options four /none for a given questions.

x. **Assignment:** A practical task or setup questions given to measure a student's knowledge, skill and ability in subject or field.

xi. **Seminar:** A student-led academic activity designed to evaluate student's ability to research, understand, and present a specific topic.

xii. **Group Discussion:** An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment

iv. Mid-term tests
A test conducted roughly halfway through an academic term or semester.

v. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.

vi. Viva-voce
An oral examination conducted to evaluate a student's in-depth knowledge, understanding, and critical thinking regarding a subject or project.

(K) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 2, 4	30	4	5	3	12
II	1,4	30	4	5	4	13
III	3,4	30	4	5	4	13
IV	3,4, 5	30	3	5	4	12
		120	**15**	**20**	**15**	**50**

Master of Science Statistics Semester-I

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25 %
		SA: Mid Term Test	25 %
2	End-Semester Examination	Written Exam	50 %

(L) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	-	-	3	2	1	1	1	2	1	1	-	-	2	3	1
CLO2	1	-	-	2	1	-	-	1	1	-	1	-	2	3	-
CLO3	1	-	2	-	1	1	-	1	-	3	-	-	2	3	-
CLO4	-	-	1	2	1	1	-	2	1	-	1	-	2	3	-
CLO5	1	1	2	3	1	3	2	2	1	-	1	-	2	3	-

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Probability Theory: An Introduction Using R	Shailaja R. Deshmukh, Akanksha S. Kashikar	First/2024	Taylor and Francis
2	Modern Probability Theory, An introductory Textbook	Bhat, B. R.	Third/1999	New Age International (P) Ltd, India
3	A First Course in Probability	Ross, S.	Ninth/2014	Pearson Edu. Dorling Kindersley (India) Pvt Ltd.
4	Probability Through Problems	Capinski, M. and Zastawniak T.	First/2003	Springer
5	Mathematical Statistics	Mukhopadhyay P.	Third/ 2006	Books and Allied Pvt. Ltd.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Probability Theory: An Introduction Using R Book by S R Deshmukh and A. S. Kashikar	https://doi.org/10.1201/9781032619057

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S01NESTA04**	Official Statistics	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Develop proficiency in designing large-scale sample surveys, sampling frames, and techniques for population census and economic surveys.

CLO2: Calculate the accuracy, consistency, and reliability of official statistics such as GDP, IIP, FAOSTATS, SDG.

CLO3: Analyze key indicators related to national income, population, agriculture, industry, trade, and labour, with a focus on Indian statistical systems.

CLO4: Apply advanced techniques for constructing index numbers, such as consumer price indices, measuring inflation, and population indices like fertility rate, mortality rate.

CLO5: Perform Network analysis, inventory modelling, and critically analyze queuing systems.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Structure of Official Statistics: • Structure of Official Statistics in India: Role, function and activities of MoSPI, CSO, NSSO, RBI, and state statistical bureaus. Organization of large-scale sample surveys. General and special data dissemination systems. • UN Fundamental Principles of Official Statistics: International standards for data quality, confidentiality, and dissemination.	CL CBL	1
II	Data Collection • Census: Census of India, civil registration system, and sample registration system. Origin and Scope of Demography, Sources of Demographic Data-Census, Vital Registration System, Population Register and Sample Surveys. Composition-Age, Sex, Religion, Caste, Education, Language, Income. • Modes System of collection of Agricultural Statistics and allied areas.	CL CBL	1 5
III	Measurement and Indices • Statistics: Trade, Finance including money supply and banking statistics, cost of living, inflation, Health, Educational and other social statistics. Index of Industrial Production (IIP). • National Accounts Statistics: GDP measurement, income accounts, and the system of national accounts. CPI, WPI, GDP deflator — construction, interpretation, and limitations. • Crop forecasting and estimation, productivity,	CL CBL	2 3 4

	fragmentation of holdings, support prices, buffer stocks, impact of irrigation projects. Minimum support price data, and FAOSTATS. SDG.		
IV	Population Studies • Population: History of population, growth, population size and growth in states, Human Development Index. • Components of population change: Fertility, Mortality, Morbidity, Causes and consequences of change • Migration and Urbanization: Types of migration, factors affecting migration, causes and consequences of urbanization, Headcount ratio, poverty gap, squared poverty gap, and Gini coefficient. • Crime and Justice Statistics: NCRB data sources, reporting biases, and international crime victimization surveys. Data portals, and API-based access to official data.	CL CBL MP	3 4 5

- **Learning Pedagogies/Methods**
  (p) Classroom Lecture (CL)
  (q) Case-Based Learning (CBL)
  (r) Micro-Projects (MP)
- **Assessment Methodologies**

(M) Internal Assessment

a. Internal Formative assessment

xiii. MCQ and Objective question Quiz: Students select or give the correct answer from the list of options four /none for a given questions.

xiv. Assignment: A practical task or setup questions given to measure a student's knowledge, skill and ability in subject or field.

xv. Seminar: A student-led academic activity designed to evaluate student's ability to research, understand, and present a specific topic.

xvi. Group Discussion: An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment

viii. Mid-term tests
A test conducted roughly halfway through an academic term or semester.

ix. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.

x. Viva-voce
An oral examination conducted to evaluate a student's in-depth knowledge, understanding, and critical thinking regarding a subject or project.

Master of Science Statistics Semester-I

(N) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	30	4	5	3	12
II	1,5	30	4	5	4	13
III	2,3,4	30	4	5	4	13
IV	3,4, 5	30	3	5	4	12
		120	**15**	**20**	**15**	**50**

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25%
		SA: Mid Term Test	25%
2	End-Semester Examination	Written Exam	50%

(O) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	**1**	-	-	-	-	**2**	**2**	**1**	-	-	-	**3**	-	-	**1**
CLO2	**1**	-	-	-	-	**2**	**2**	**1**	-	-	-	**3**	-	-	
CLO3	**1**	-	-	-	-	**2**	**2**	**1**	**3**	-	-	**3**	-	-	**1**
CLO4	**1**	-	-	-	-	**2**	**2**	**1**	-	-	**3**	**3**	-	-	**1**
CLO5	**1**	-	-	-	-	**2**	**2**	**1**	-	-	-	**3**	-	-	**1**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Indian Official Statistical Systems	Saluja M. R.	First/1972	Statistical Pub. Society

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	RBI: Handbook of Statistics for the Indian Economics	https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook+of+Statistics+on+Indian+Economy
2	Economic Surveys, Govt. of India, Ministry of Finance (various years)	https://www.indiabudget.gov.in/economicsurvey/
3	CSO Publication: Statistical System	https://www.mospi.gov.in/

	in India	

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S01NCSTA02**	Practical (LMR, Fitting of Distributions) through R	0-4-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Determine suitable theoretical distributions (Normal, Exponential, Poisson, Gamma, etc.) for given datasets using graphical methods and statistical tests.

CLO2: Estimate parameters of probability distributions representing characteristics of data in R.

CLO3: Quantify the quality of fit using statistical tests such as Kolmogorov-Smirnov, Anderson-Darling, and Chi-squared tests in R.

CLO4: Perform ANOVA of having one-way, two-way classification model and determine significant factor levels using the lm() function in R. Obtain p-values, and confidence intervals to evaluate model significance and predictive power.

CLO5: Effectively communicate findings by interpreting statistical results within the context of the research problem.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Practice of Fitting of Distributions • Fitting of binomial and multinomial distribution MCQ scores • Fitting of normal and bivariate normal distribution height and weight data	CL CBL	1 2 3 5
II	Fitting of some non-normal distributions • Fitting of exponential and Weibull distribution to life time data • Fitting of Gamma and Beta distribution	CL CBL	1 2 3 5
III	Exploratory Data Analysis Linear Models • One-way classification data from a real-life field • Two-way classification data from a real-life field • Two-way classification data having interaction from a real-life field • Two-way classification percentage data	CL CBL	4 5
IV	ANOVA of Linear Models with Multiple comparisons • One-way classification data from a real-life field • Two-way classification data from a real-life field • Two-way classification data having interaction from a real-life field • Two-way classification percentage data	CL CBL	4 5

- **Learning Pedagogies/Methods**

(s) Classroom Lecture (CL)

(t) Case-Based Learning (CBL)

- **Assessment Methodologies**

(P) Internal Assessment

a. Internal Formative assessment

xvii. Group Discussion: An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment

xi. Mid-term tests
A test conducted roughly halfway through an academic term or semester.

xii. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.

(Q) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 2, 3, 5	30	4	5	3	12
II	1, 2, 3, 5	30	4	5	4	13
III	4,5	30	4	5	4	13
IV	4,5	30	3	5	4	12
		120	**15**	**20**	**15**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25%
		SA: Mid Term Test	25%
2	End-Semester Examination	Written Exam	50%

(R) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	**1**	-	**2**	**2**	**2**	-	-	-	**2**	-	-	-	**3**	**1**	**1**
CLO2	**2**	-	**2**	**2**	**2**	-	-	-	**2**	-	-	-	-	**1**	-
CLO3	**2**	**2**	**2**	**2**	**2**	-	-	-	**3**	-	-	-	-	**1**	-
CLO4	**2**	**2**	**2**	**2**	**2**	**2**	-	-	**2**	-	-	-	-	**1**	-
CLO5	**2**	-	**2**	**2**	**2**	**2**	-	-	**2**	**3**	-	-	-	**1**	-

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Linear Models with R	Julian J Faraway	First/2005	Chapman and Hall CRC

Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S01NCSTA03**	Practical (TH, OR, OFS) through Excel	0-4-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Develop proficiency in analyzing large-scale sample surveys, sampling frames, and techniques for population census and economic surveys.

CLO2: Calculate and report results of data analysis, official statistics with a focus on Indian statistical systems.

CLO3: Perform MP, UMP, LR, SPR Tests and make decision.

CLO4: Apply matrix algebra, network models, and queueing theory concepts using computational tools to analyze real-world data and communicate results effectively.

CLO5: Competency to read report of the MoSPI, CSO, NSSO, RBI, and state statistical bureaus.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Practice of Testing of Hypotheses • MP test for Government problem and data. • UMP test for biology problem and data • UMPU test for chemistry problem and data • LR test for engineering two sample problem and data • LR test for Computer Science k (more than two) sample problem and data • SPR and test for industrial data	CL CBL	3 5
II	Operations Research techniques • Deterministic Inventory Models and Their Applications • Probabilistic Inventory Models and Analysis • Queueing Theory Models and Analysis.	CL CBL	4
III	Measurement and Indices • Re-calculation of MoSPI report for consumer indices • Re-calculation of MoSPI report for Industrial indices • Re-calculation of MoSPI report for Agriculture indices • Re-calculation of MoSPI report for population indices	CL CBL	1 2 5
IV	NFHS Studies • Descriptive Analysis of NFHS Data • Inferential Analysis of NFHS Data	CL CBL MP	1 5

- **Learning Pedagogies/Methods**
  (u) Classroom Lecture (CL)
  (v) Case-Based Learning (CBL)
  (w) Micro-Projects (MP)

- **Assessment Methodologies**

(S) Internal Assessment

a. Internal Formative assessment

xviii. Group Discussion: An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment

xiii. Mid-term tests
A test conducted roughly halfway through an academic term or semester.

xiv. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.

(T) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	3, 5	30	4	5	3	12
II	4	30	4	5	4	13
III	1,2,5	30	4	5	4	13
IV	1,5	30	3	5	4	12
		120	**15**	**20**	**15**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	25%
		SA: Mid Term Test	25%
2	End-Semester Examination	Written Exam	50%

(U) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	**1**	-	-	-	-	**2**	**2**	**1**	-	-	-	**3**	-	-	**1**
CLO2	**1**	-	-	-	-	**2**	**2**	**1**	-	-	-	**3**	-	-	
CLO3	**1**	-	-	-	-	**2**	**2**	**1**	**3**	-	-	**3**	-	-	**1**
CLO4	**1**	-	-	-	-	**2**	**2**	**1**	-	-	**3**	**3**	-	-	**1**
CLO5	**1**	-	-	-	-	**2**	**2**	**1**	-	-	-	**3**	-	-	**1**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Indian Official Statistical Systems	Saluja M. R.	First/1972	Statistical Pub. Society

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	RBI: Handbook of Statistics for the Indian Economics	https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook+of+Statistics+on+Indian+Economy
2	Economic Surveys, Govt. of India, Ministry of Finance (various years)	https://www.indiabudget.gov.in/economicsurvey/
3	CSO Publication: Statistical System in India	https://www.mospi.gov.in/

Master of Science Statistics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S01NCSTA04**	Management Tools for Industry Mapping	1-1-0	60	02

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Analyze complex industrial environment using strategic framework and identify competitive advantages and potential bottlenecks.

CLO2: Map cause-and-effect links among complex, interdependent factors in a business or production process.

CLO3: Identify, define and differentiate the 7 new management tools from the 7 QC tools.

CLO4: Utilize AI-powered analysis tools (eg. GitMind, Creately) for brainstorming and industrial trends.

CLO5: Formulate strategic recommendations for business transformation by synthesizing findings from industry mapping and management tools analysis.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Foundations of Industry Data and Mapping • Industry Classification Frameworks: Understanding Standard Industrial Classification (SIC), NAICS, and regional classifications for data structuring. • Data Acquisition for Industry Mapping: Identifying and sourcing industrial data (e.g., government data, stock exchanges - BSE/NSE). • Process Mapping: Flowcharts, Value Stream Mapping (VSM), and Micro and Macro process visualization.	CL CBL ICT EL	1 2 4
II	Seven New Management Tools • Idea Structuring and Relationship Tools: Affinity Diagram (KJ Method), Interrelationship Digraph (Relations Diagram) Tree Diagram • Planning, Analysis & Risk Management Tools: Matrix Diagram, Matrix Data Analysis Chart, Arrow Diagram (Activity Network Diagram), Process Decision Program Chart (PDPC)	CL CBL ICT EL	1 3 5

- **Learning Pedagogies/Methods**
  (x) Classroom Lecture (CL)
  (y) Case-Based Learning (CBL)
  (z) ICT-Enabled Learning through Digital Resources/ Virtual Labs/Webinars (ICT EL)
- **Assessment Methodologies**
  (V) Internal Assessment

a. Internal Formative assessment (15 Marks)

xix. MCQ and Objective question Quiz: Students select or give the correct answer from the list of options four /none for a given questions.

xx. Group Discussion: An interactive method to asses a student's personality and inter- personal skills in team setting. It typically involves 5 to 15 participants discussing a topic for 15 to 30 minutes in presence of an observer.

b. Internal Summative Assessment (10 Marks)

xv. Mid-term tests
A test conducted roughly halfway through an academic term or semester.

xvi. Laboratory performance
Students demonstrate their laboratory hands-on performance skills, knowledge and ability to apply concepts in subjects.

(W) Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 2, 4	30	4	9	12	13
II	1, 3, 5	30	4	9	12	12
		60	**8**	**18**	**24**	**25**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	FA: Seminars, Assignments, Quizzes, Group Discussion	15
		SA: Mid Term Test	10

(X) CLOs – PLOs Matrix

CLO	PLO														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	**1**	-	-	-	**1**	**1**	**1**	-	-	**1**	-	**1**	-	-	**1**
CLO2	**1**	-	-	-	**1**	-	-	-	-	-	-	**1**	-	-	**1**
CLO3	**1**	-	-	-	**1**	**1**	-	-	-	**1**	-	**1**	**2**	-	**1**
CLO4	**1**	-	-	-	**1**	-	-	-	**1**	-	-	**1**	-	-	**1**
CLO5	**1**	-	-	-	**1**	**1**	-	-	-	-	-	**2**	-	-	**3**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	The Memory Jogger Plus+: Featuring the seven Management and Planning Tools	Michael Brassard	First/1996	Goal Q P C Inc.
2	The Visual Display of Quantitative Information	Tufte, E. R.	Second/2001	Graphics Press